ECEN 150 Lab 8 – Thevenin & Norton circuits

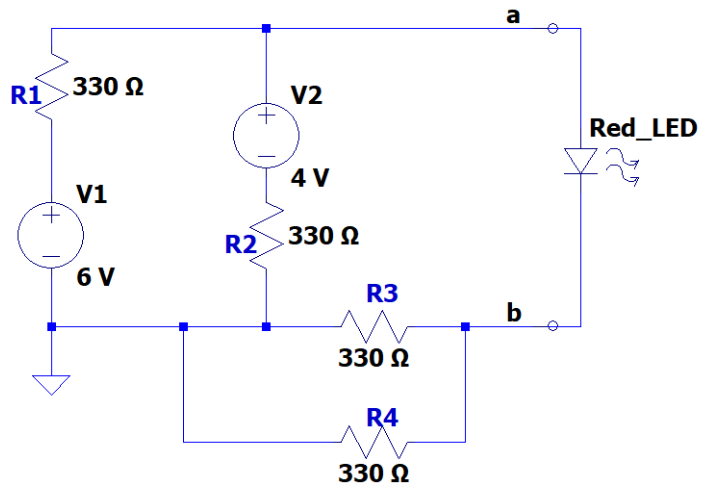
Name: Brodric Young

Purposes: (46 points total)

- Practice Thevenin calculations and source transformations (to Norton)
- Experimentally confirm Thevenin's Theorem.
- Construct a Thevenin equivalent circuit and demonstrate equivalence to the original.

Procedure:

Part 1. Calculate Thevenin equivalent circuit



Step 1: Determine R_{th}.

- Calculate Rth for this circuit from point a to point b. Show your work in the space below. *It should be between 300 – 400 Ω.

Question 1a: R_{th} value: ______330Ω _____ (1 point)

Question 1b: Show your work for R_{th} (5 points for showing correct work)

(Show your work for calculating R_{th} here, either as a photo or typed)

R1 | | R2 = 165 Ω

R3 || R4 = 165 Ω

R_{th} = (R1 || R2) + (R3 || R4) = 330 Ω

Step 2: Determine V_{th}

- Calculate V_{th} for the circuit above. Hints:
  - R3 & R4 are in parallel.
  - KVL or Ohm's Law are all that are needed to complete this (no Nodal or mesh)
  - Vth should be between 4.5 – 5.3 V.

Question 2a: V_{th} value: ______5V_______ (1 point)

Question 2b: Show your work for V_{th}. (5 points for showing correct work)

(Show your work for calculating V_{th} here, either as a photo or typed)

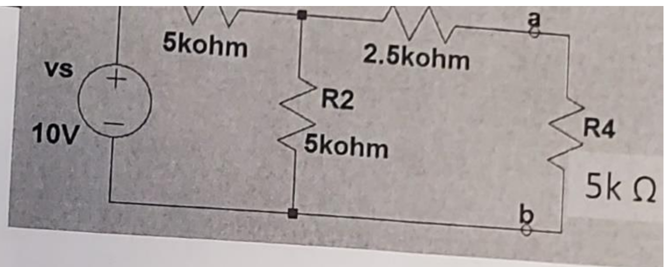
$-6V + i \cdot R1 + 4V + i \cdot R2 = 0$

$i\,330 + i\,330 = 2V$

$i(330 + 330) = 2V$

$i = 0.003\,A$

$0.003A \cdot 330\Omega = 1V$



$6V + V_{R1} = 6V - 1V = 5V$

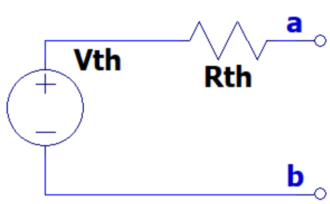
$V_{R2} + 4V = 1V + 4V = 5V$

$V_a = 5V$

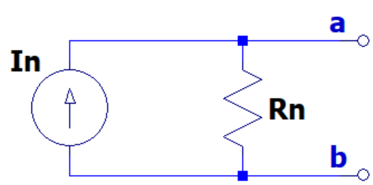
$V_b = 0V$ $\rightarrow V_{ab} = 5V$

Question 3: Convert your Thevenin circuit (V_{th} in series with R_{th}) into an equivalent current source (I_n in parallel with R_n). Use a simple source transformation to accomplish this.
*This equivalent current source is also known as a "Norton equivalent" circuit with I_n being the short-circuit current.

Thevenin equivalent



Norton equivalent



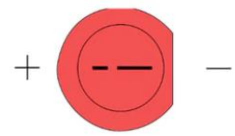
What are those component values?

- I_n = ______15.2mA______ (1 point)
- R_n = _____330 Ω _____ (1 point)

Part 2. Construct and measure the original circuit

Step 1: Construct & measure the loaded circuit.

LED top-down orientation



- **Construct the circuit from Page 1**. Use minimal wires (zero or one).
- The LED is the "load" and should be glowing when finished.
- **Measure** the voltage across the LED (i.e., the load voltage V_{ab}). Enter the value in the table below. *It should be around 1.8 V.

Step 2: Measure V_{th}.

- **Remove the LED**.
- **Measure** the Thevenin voltage V_{th} (i.e., the voltage from a-b) using the digital multimeter.
  - Banana-to-**clip** cables will likely be easiest for this.
- **Enter** your measurement in the table below. It should match the calculated value.

Step 3: Measure I_n (i.e., I_{ab} or the short-circuit current).

- Configure your multimeter to measure current. *Check with a TA!
- **Measure** the short-circuit current I_n (i.e., the current from a-b) using the digital multimeter. **Enter** your measurement in the table below. It should match the calculated value.

Step 4: Measure R_{th}

- Turn off the power supply & disconnect from the circuit.
- Replace both voltage sources in the circuit with shorts (the equivalent of an off-state voltage source)
- **Measure** the Thevenin resistance R_{th} (i.e., the resistance from a-b) using the digital multimeter. **Enter** your measurement in the table below. It should match the calculated value.

(19 points)	**Calculated**	**Measured** Original circuit	**Measured** Thevenin circuit
V_{ab} with LED	(Don't calculate)	___1.845V_____ (2pts) (Part 2, Step 1)	____1.840V____ (2pts) (Part 3, Step 1)
V_{th} (no LED)	____5V____ (1pt) (from Question 2a)	____5.035V____ (2pts) (Part 2, Step 2)	____5.033V____ (2pts) (Part 3, Step 2)
I_n (i_{ab} without LED)	____15.2mA___ (1pt) (from Question 3)	____14mA____ (2pts) (Part 2, Step 3)	____15.4mA____ (2pts) (Part 3, Step 3)
R_{th}	____330Ω ____(1pt) (from Question 1a)	____329 Ω ____ (2pts) (Part 2, Step 4)	____326 Ω ____ (2pts) (Part 3, Step 4)

Part 3. Construct and measure the Thevenin equivalent circuit

Step 1: Construct & measure the loaded Thevenin equivalent circuit.

- Construct the Thevenin equivalent circuit on a breadboard, and use it to drive the LED as the load. The LED should be glowing.

*For all measurements of this circuit *in this and subsequent steps,* ensure you have reconfigured the multimeter properly!

- **Measure** the voltage across the LED (i.e., the load voltage V_{ab}). Enter the value in the table on Page 3.

Step 2: Measure V_{th}

- Remove the LED. Measure V_{ab}. **Record** in the table on Page 3. (just like Part 2, Step 2).

Step 3: Measure I_n (i.e., I_{ab} or the short-circuit current).

- **Turn off the source. Configure to measure** the short-circuit current. *Check with a TA before turning back on! **Record** in the table on Page 3. (just like Part 2, Step 3).

Step 4: Measure R_{th}

- Turn off the power supply. Remove the supply from circuit & replace with a wire.
- **Measure** R_{th}. **Record** in the table on Page 3. (just like Part 2, Step 4).

Question 4: Compare the measured values from the original circuit vs. the Thevenin circuit (see your table). They should be nearly identical. Does this mean the two circuits are equivalent as seen by the load? Why? Use complete sentences. (3 points)

Yes they are equivalent as seen by the load. By combining the resistor values the current takes from the path of the terminals of the load and then finding the voltage across those terminals, it's the same thing as the big complicated circuit.

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*****To pass off your circuit, demo it to the TA or instructor and take Lab 8: Quiz 1*****

Part 5. Conclusions statement.

Write a brief conclusions statement that discusses all of the original purposes of the lab. Please use complete sentences and correct grammar to express your thoughts on how you fulfilled the purposes of the lab:

Purposes (repeated):

- Practice Thevenin calculations and source transformations (to Norton)
- Experimentally confirm Thevenin's Theorem.
- Construct a Thevenin equivalent circuit and demonstrate equivalence to the original.

Conclusions (10 points):
In this lab we practiced calculating the Thevenin equivalent voltage and resistance from the complicated schematic to simplify the circuit as seen by the load. We also practiced transforming that Thevenin equivalent circuit to the Norton equivalent circuit. To confirm our calculations were correct, and to see that this actually works, we constructed both the complicated circuit and the simplified equivalent circuit and measured the values. They turned out to be nearly the same values (within measurement errors) of each other showing that the Thevenin equivalent circuit is equivalent to the original complicated circuit.

Congratulations, you have completed Lab!
You may now submit this document.